JAXA GPM Science Status

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Global Precipitation Measurement

JAXA PMM Science

41 PIs in 3 groups

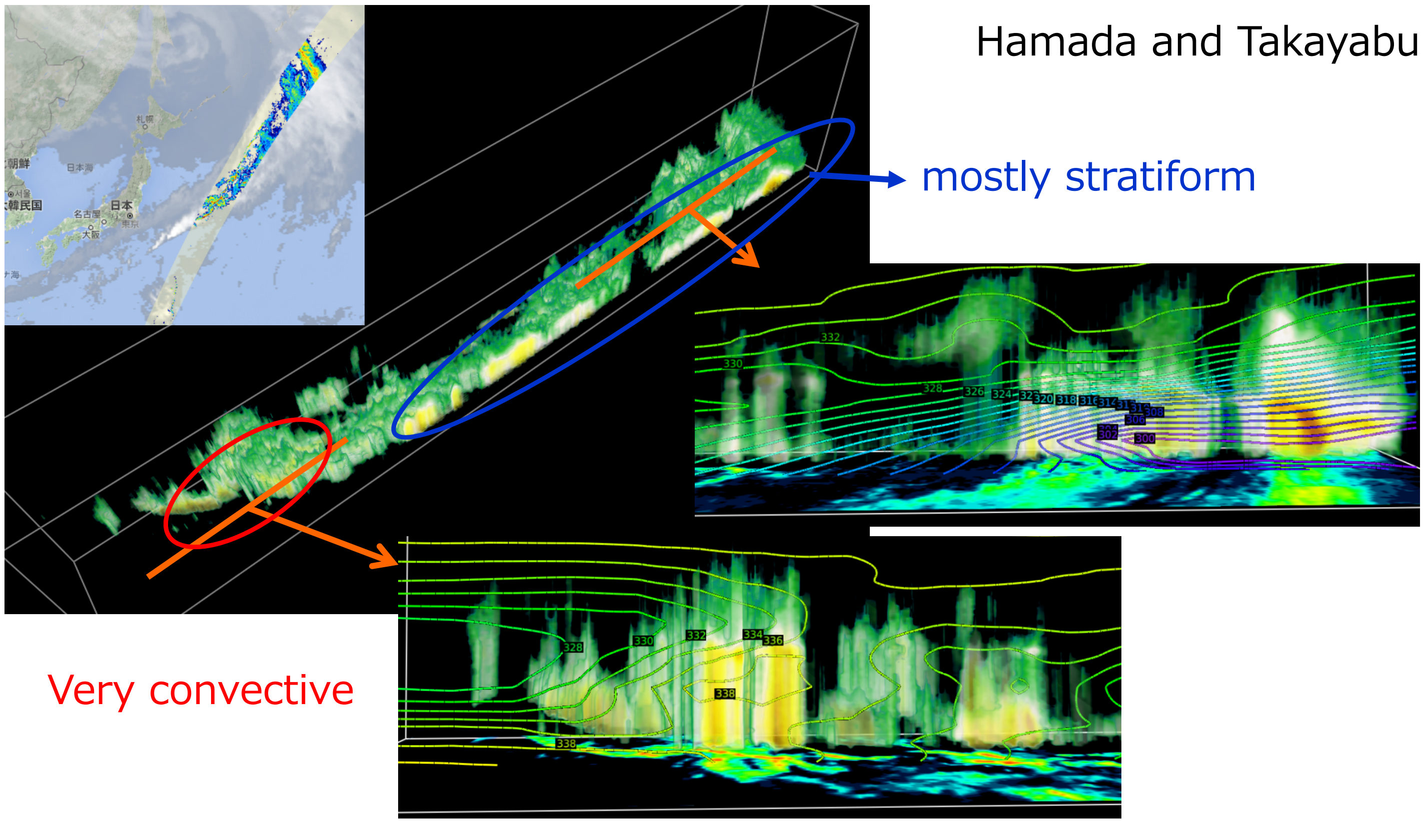
1. Algorithm Developments 10
2. Ground Validations 17
3. Applications 14

+ EORC studies

Global Precipitation Characteristics -midlat vs tropics-

3D structure of a midlatitude front observed with GPM/DPR

Hamada and Takayabu



We would like to examine entire 3D precipitation structures of midlatitude fronts, and connect them to latent heating

Two-year Stats of DPR-captured Precipitation Systems

M. Hirose (Meijo U)

Dark-colored shading: rain within 1 hr of the time of max rain preserves positive anomalies.

Number of rain samples 0.1deg

Time of max hourly rain 1deg

Small

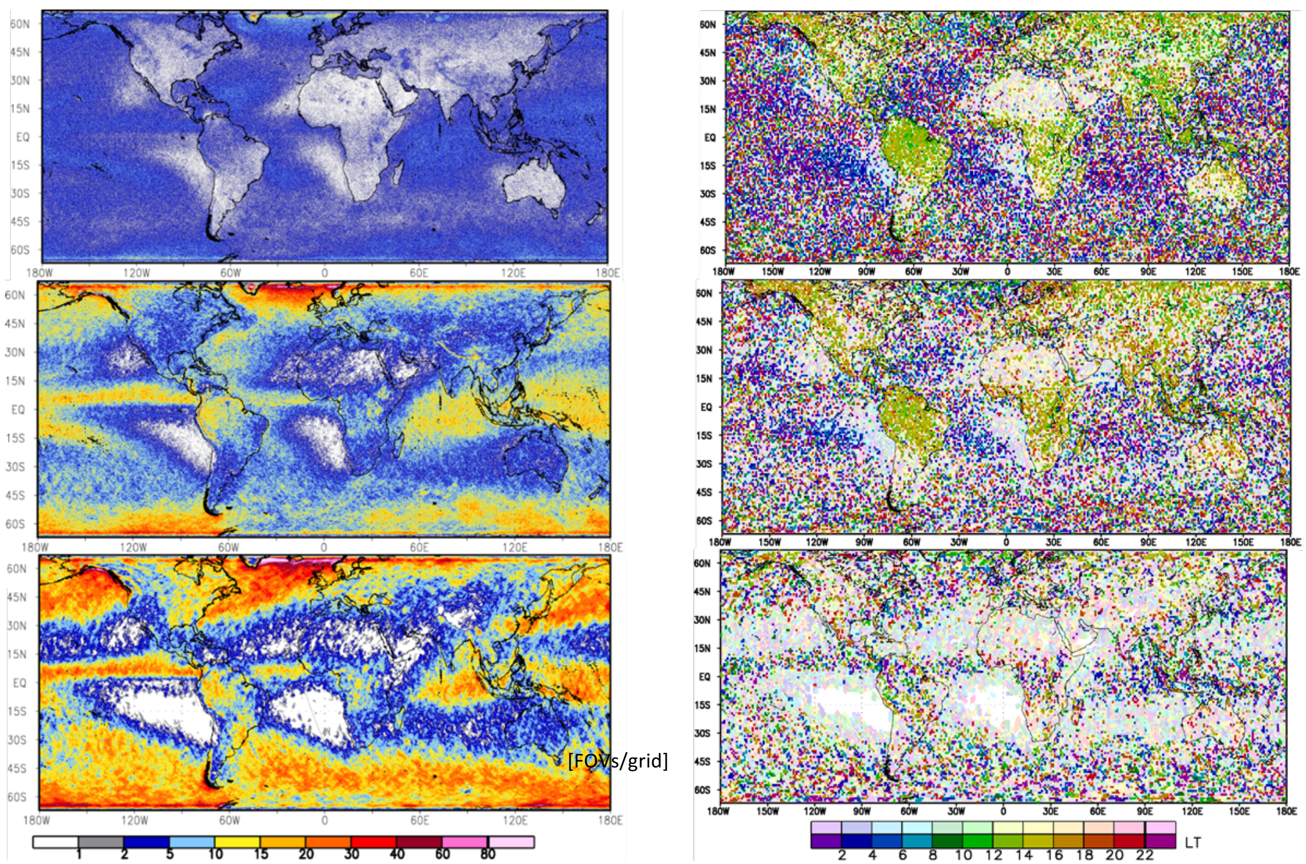
<10km

Medium

10-100km

Large

>100km



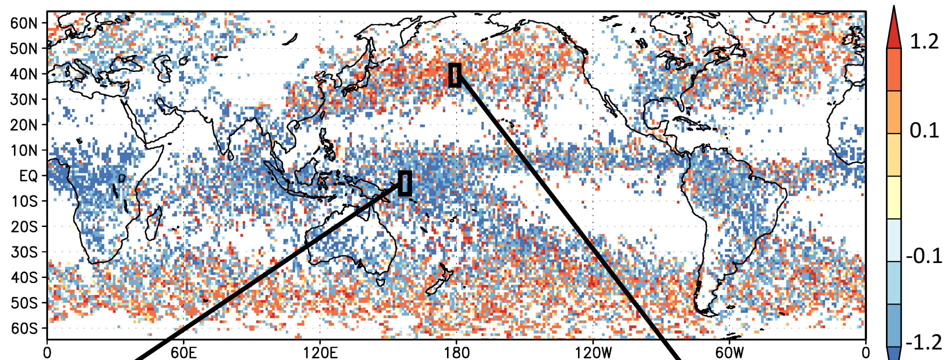
KuPR 04A
2014/4-2016/3

Profiles in Tropical and Midlatitude Stratiform Regions with Ku-band

Poster #229

Kazuki Kobayashi, *Shoichi Shige and Munehisa K.

■Global distribution of DZ (MAM2014/2015) (dBZe[near surface] > 18dBZ)



Definition of DZ

$$DZ \equiv dBZe[near\ surf] - dBZe[BBb]$$

*Using detected BB and classified as stratiform

DZ<0 in Tropics (Downward Decreasing)

⬍

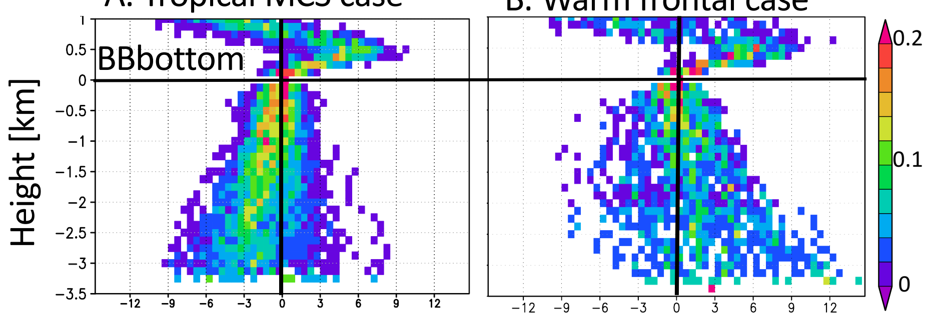
DZ>0 in Midlatitudes (Downward Increasing)

Vertical gradients of Ku Ze below BB in stratiform precipitation are investigated

■Histogram of the dBZe profiles

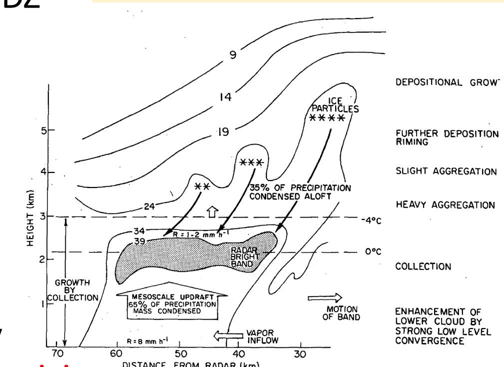
A. Tropical MCS case

B. Warm frontal case



Downward decreasing reflectivity
⇒ Evaporation of raindrops

Downward increasing reflectivity
⇒Growth of particles

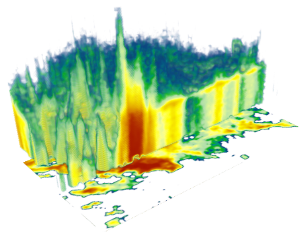


Houze et al. (1981)

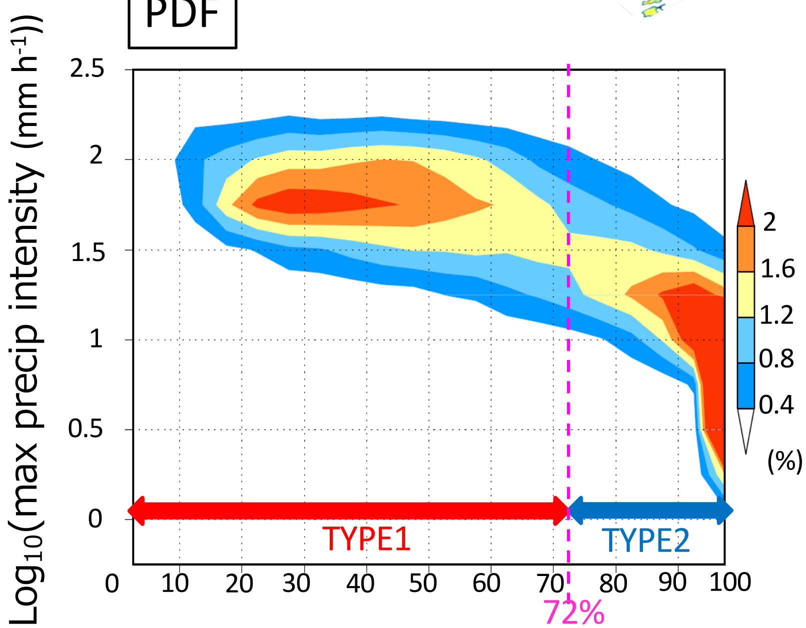
Mesoscale precip. systems in the tropics vs midlatitudes

Yokoyama,Takayabu and Horinouchi, partially submitted

Statistics of “Rainfall events” defined with the GPM Ku-band radar



PDF

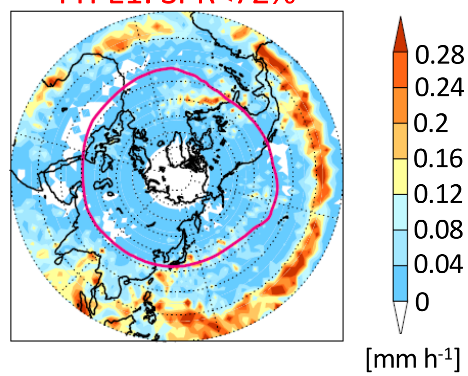


Stratiform precipitation ratio (SPR; %)

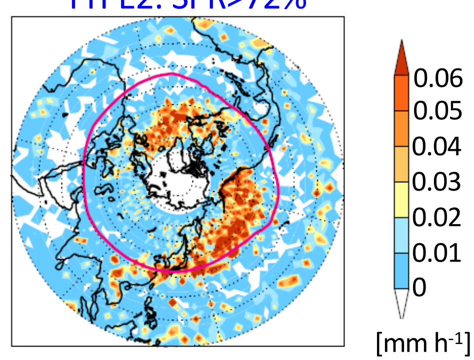
Distributions

(April 2014-March 2015)

TYPE1: SPR<72%



TYPE2: SPR>72%

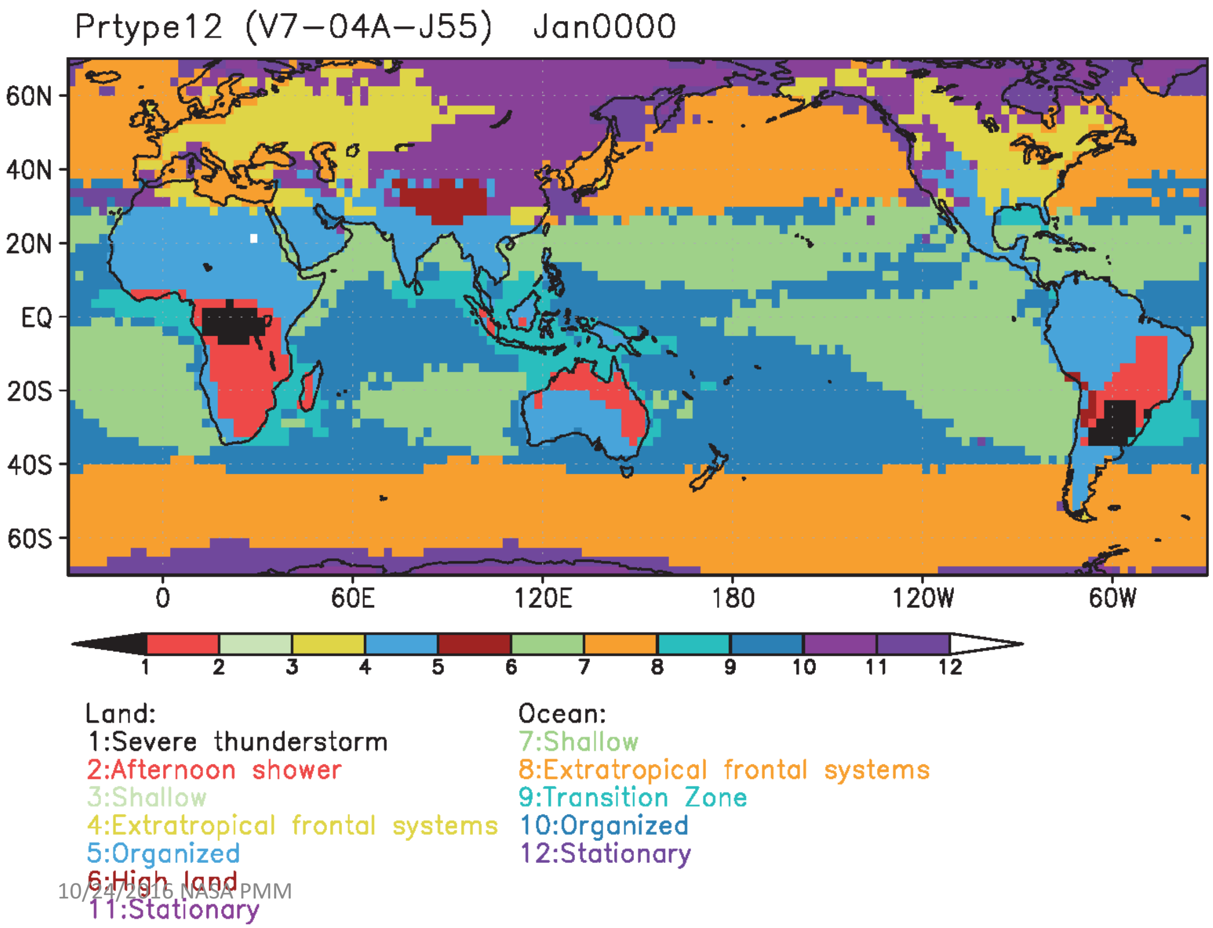


Global mesoscale (D>60km) precipitation systems can be classified into two types in terms of the Strat. Precip. Ratio around 70-80%

I. Tropical organized systems
II. Extratropical systems

Precipitation regime map

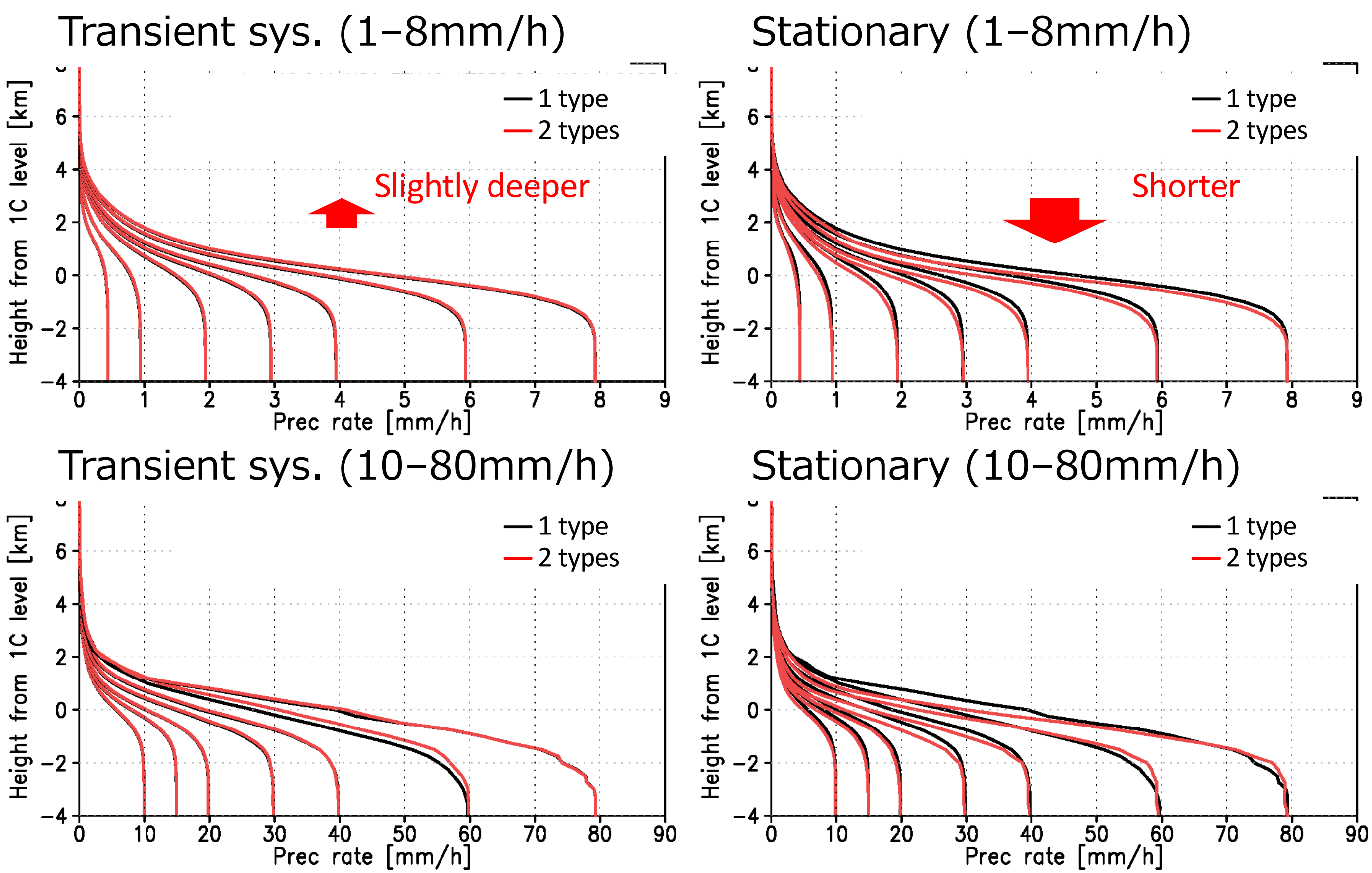
Hamada and Takayabu (U. Tokyo)



In order to aid the microwave retrievals of precipitation, precipitation regimes are defined for each month.

For the GPM era, we classified the midlatitude systems into four regimes, namely, transient extratropical frontal systems and stationary monsoon outflows, over ocean and over land, utilizing daily analysis data.

Impacts of Mid-lat classifications on Prec. Profiles
(black: 1 type / red: 2 types)



Depths of the precipitation are obtained in surface rainfall bins from KuPR. Differences b/w transient and stationary regimes are noticed. These profiles are utilized in precipitation retrievals for GSMaP.

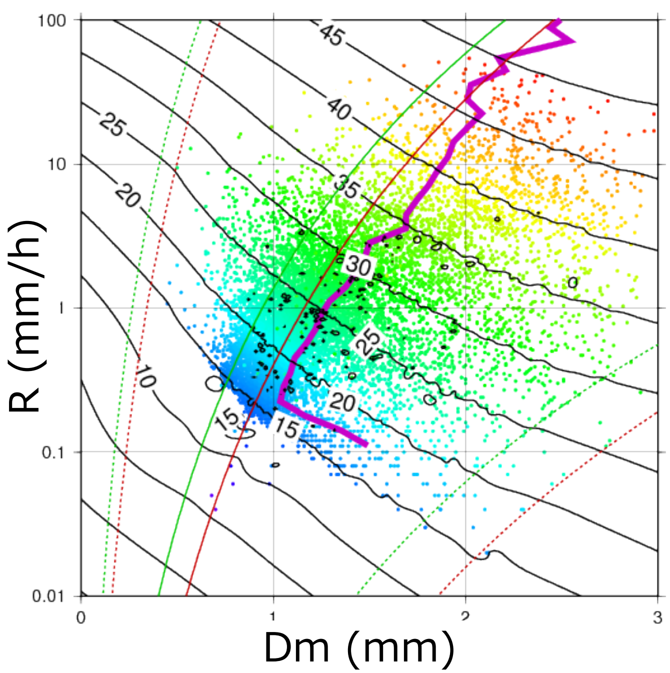
NOTE: black lines are identical between left and right panels

Precipitation Microphysics studies utilizing DPR

Precipitation Rate (R) and Mass-Weighted Mean Diameter (Dm) obtained from the DPR dual-freq algorithm

PI: S. Seto (Nagasaki U.)

DPR (dual-frequency)
Only 12 orbits in July 2014
Over Land (all over the world)
Including both Strat. and Conv.
Relative Humidity < 80%



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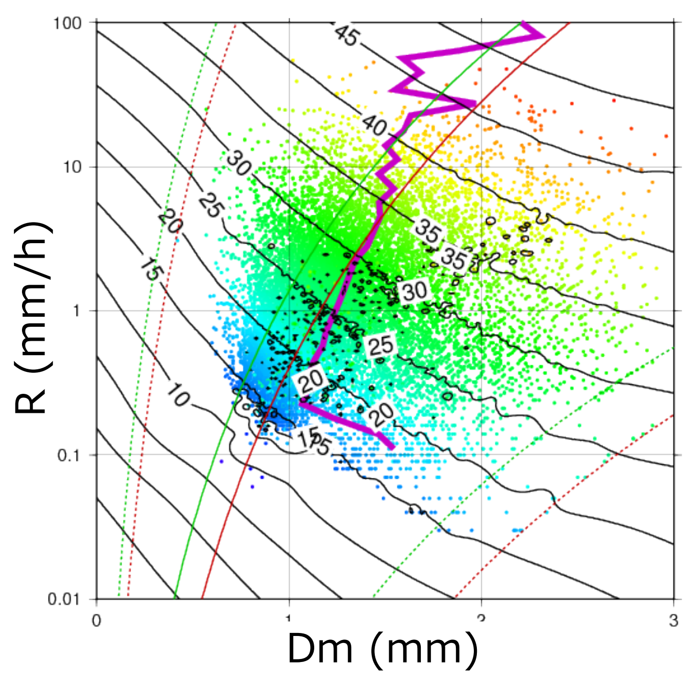


The original assumption
red line : stratiform
green line: convective

Color: Ze
purple line:
average estimate

Dm is larger when RH is lower. It may be partly due to evaporation of small rain drops.

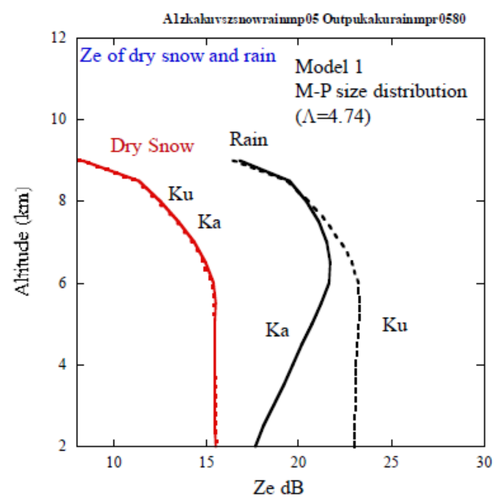
Identifications of Precipitation microphysics

- A new method of rain/snow classifications is proposed utilizing observed Differential Freq. Ratio (DFRm) between Ku and Ka by Kobayashi(MRI)

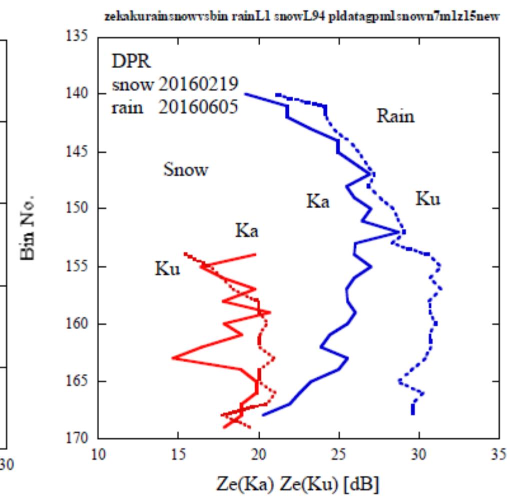
Next in Toshio's talk,
Utilizing Dual Freq. method,

- Hail+graupel+heavy snow detection (Iguchi)
- New type in convection category for lake effect (Awaka)
- New Anvil flags (Awaka)

became available



Marshall-Palmer



GPM DPR

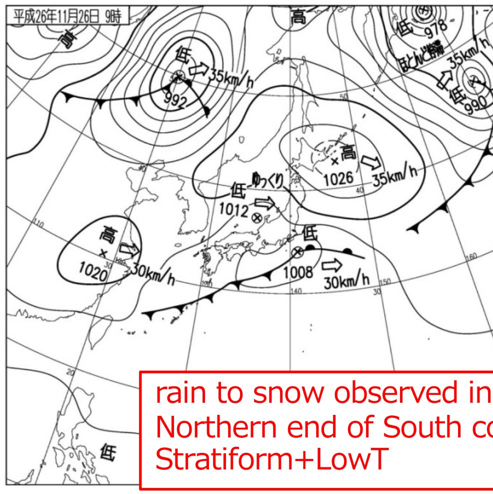
Dry snow/Rain(wet snow) classifications

Global Precipitation Measurement

Ground Validations

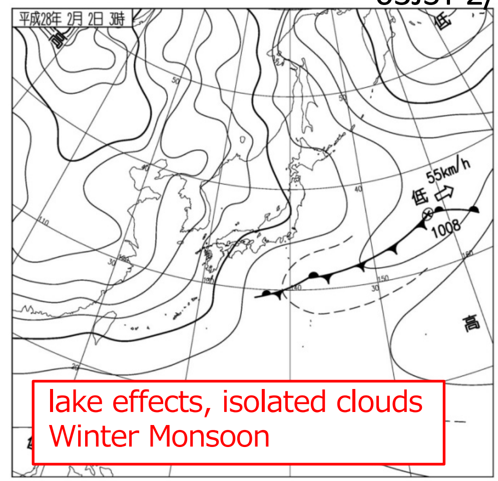
GV in winter season

Zao 06JST 11/25/2014

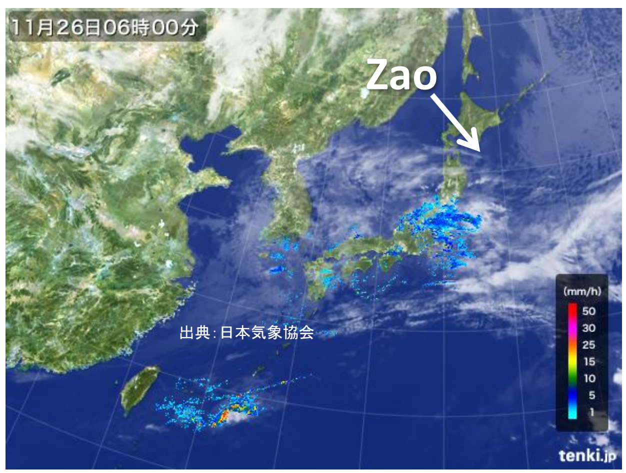


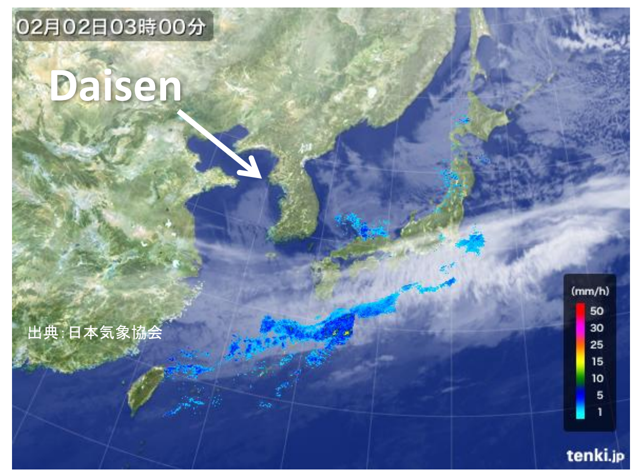
rain to snow observed in
Northern end of South coast low
Stratiform+LowT

Daisen 03JST 2/2/2016



lake effects, isolated clouds
Winter Monsoon

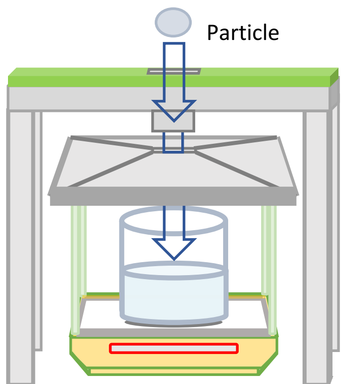


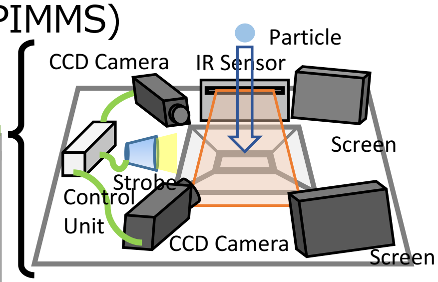


Precipitation Particle Measurements

PI: Suzuki (Yamaguchi U)

Ground-based Particle Images and Mass Measurement System (G-PIMMS)





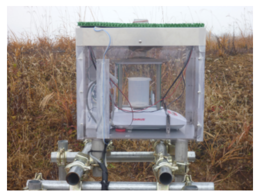
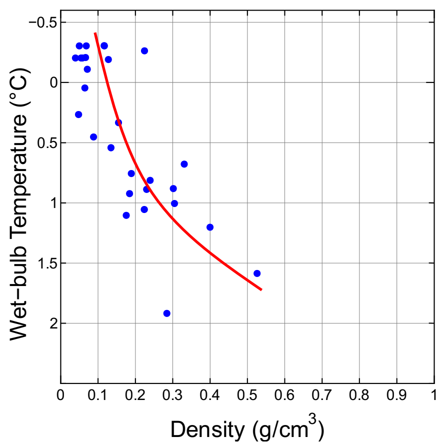
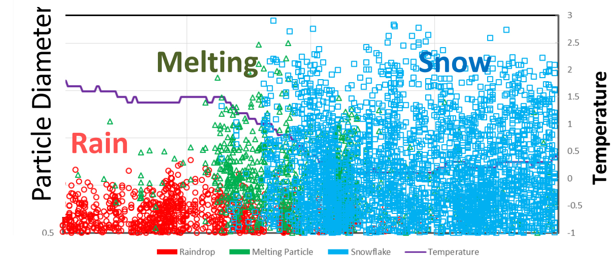


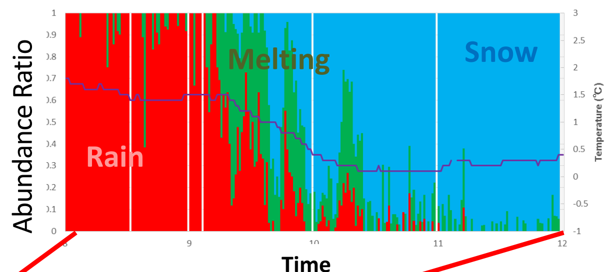
Photo of G-PIMMS

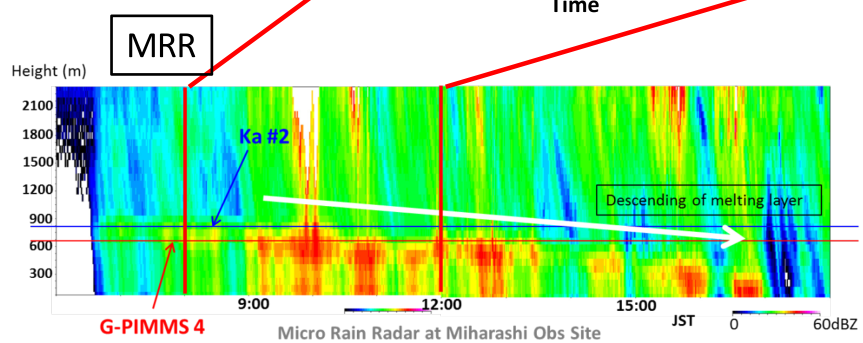


Case of Nov. 26, 2014 @ Zao

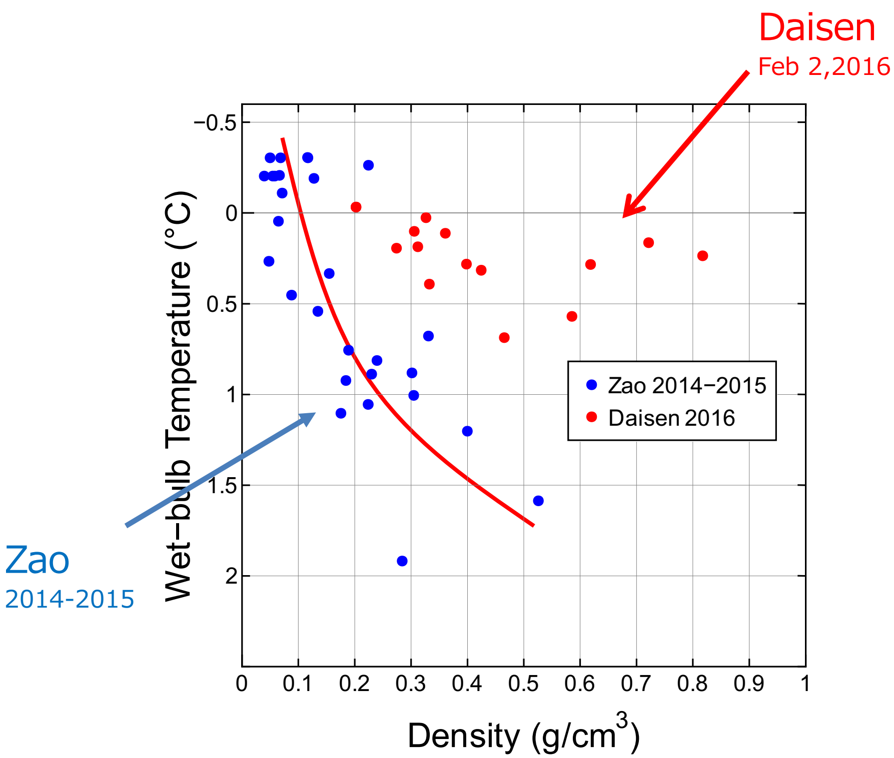


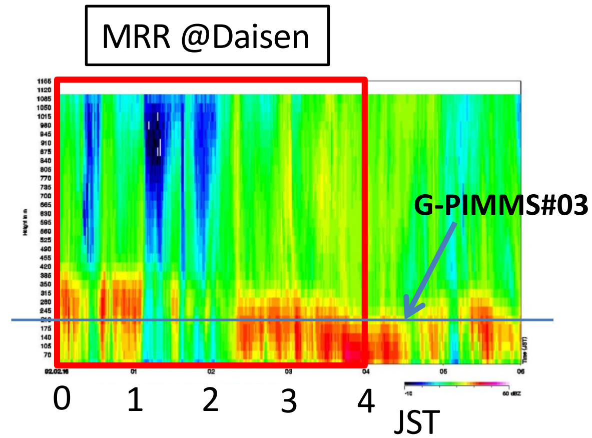
Transition from rain to snow





Relationship between Tw and density @Zao and @Daisen



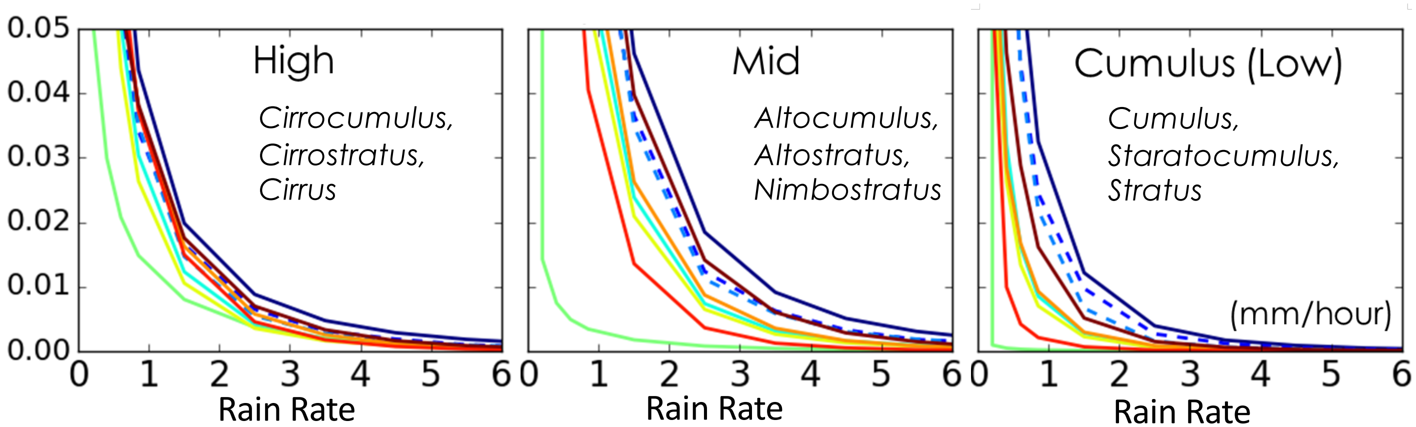


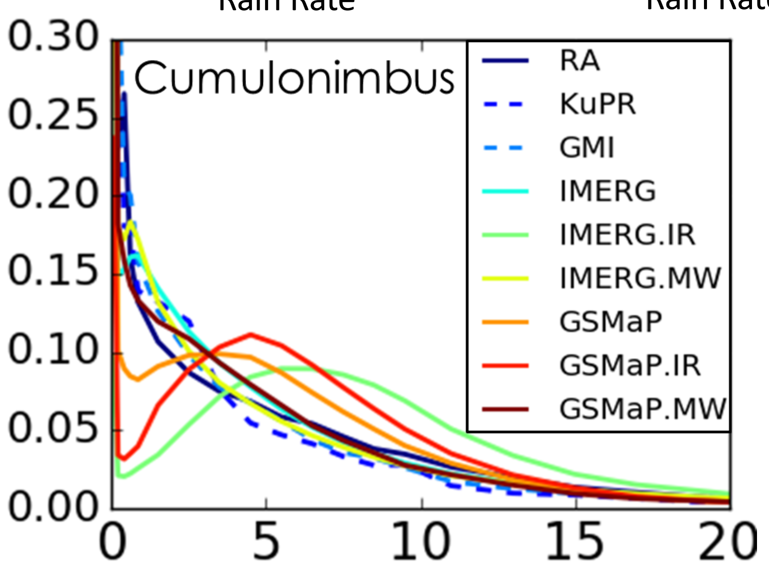
Tw-Density relationship at Daisen differed from those at Zao. It may be due to the convective nature of precipitation in Daisen, in contrast to more stratiform nature of precip. in Zao.

Study is now ongoing.

Retrieval Sensitivity by Cloud Types

PI: H. Kim (U Tokyo)





* *Satellite Cloud Grid Information over Western North Pacific by JMA*

* *Visible and Infrared (IR) from Himarwari-6 (0.2 x 0.25 deg., hourly)*

* *Lower clouds → more serious underestimation by IR retrieval*

* *Current IR algorithms tend to show significant retrieval errors for cloud with deep vertical structure (e.g., cumulonimbus).*

Based on JMA cloud information dataset over the western North Pacific, retrieval sensitivity of precipitation products by cloud types are investigated.

Mapped products are divided into IR-only retrieval grids and MW-available grids, and compared with Radar AMeDAS (ground based) rainfall as a truth.

Included in Oki's and Iguchi's talks

- A validation of precipitation estimates utilizing AMeDAS rain gauges over Japan
- A validation of precipitation estimates utilizing MRMS/NMQ data over US, with collaborations of NASA GV team

are also conducted

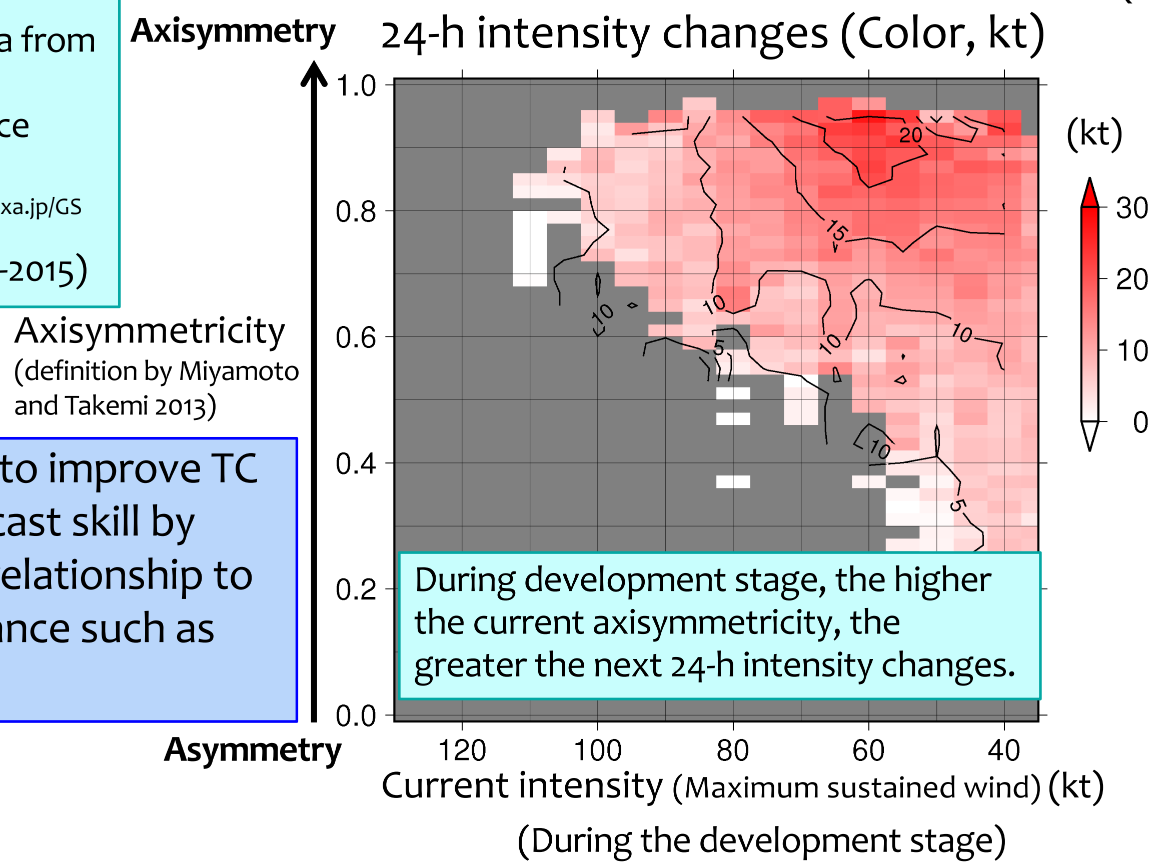
Tropical Cyclones

TC Intensification and Axisymmetricity Deduced from GSMaP 2000-2015

PI: U. Shimada (MRI)

Data

- ✓ Best track data from RSMC Tokyo
- ✓ GSMaP (Surface rainfall data)
  http://sharaku.eorc.jaxa.jp/GSMaP/index.htm
- ✓ 380 TCs (2000-2015)



It is expected to improve TC intensity forecast skill by applying this relationship to forecast guidance such as SHIPS.

Data Assimilation

GPM/DPR Data Assimilation at JMA

PI: Ikuta (JMA)

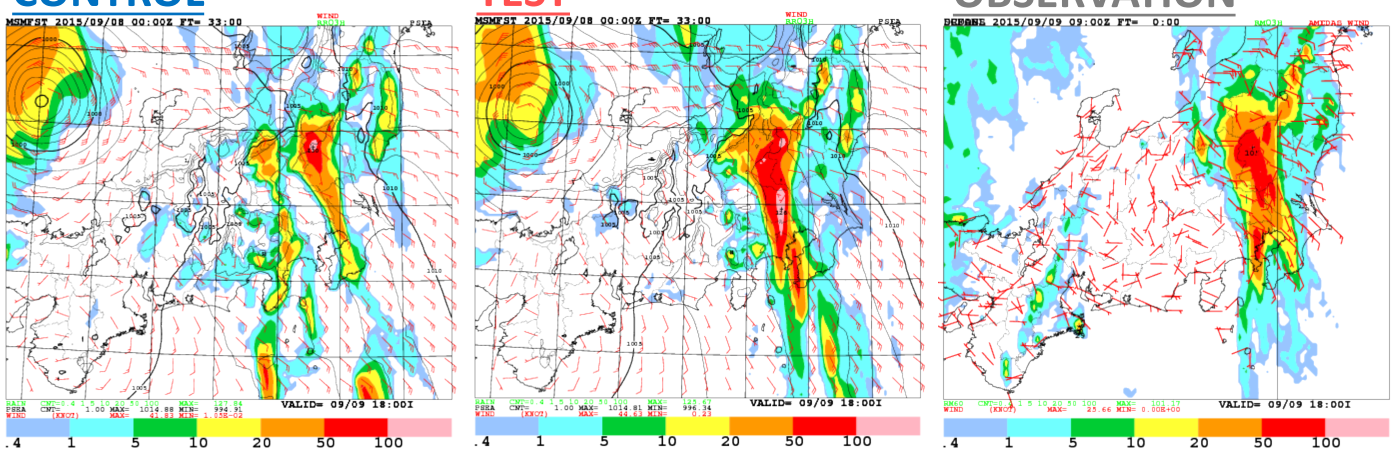
- Operational assimilation of GPM/DPR started in March 2016 at JMA.
- JMA is the first NWP center to use space-borne radar data operationally.

CONTROL: Experiment without GPM/DPR

TEST: Experiment with GPM/DPR

OBSERVATION: Radar/Rain gauge-Analyzed Precipitation and AMeDAS

CONTROL **TEST** **OBSERVATION**



Lead time: 33-hour

Initial time: 2015-09-08 00UTC

Humidity obtained from DPR is assimilated

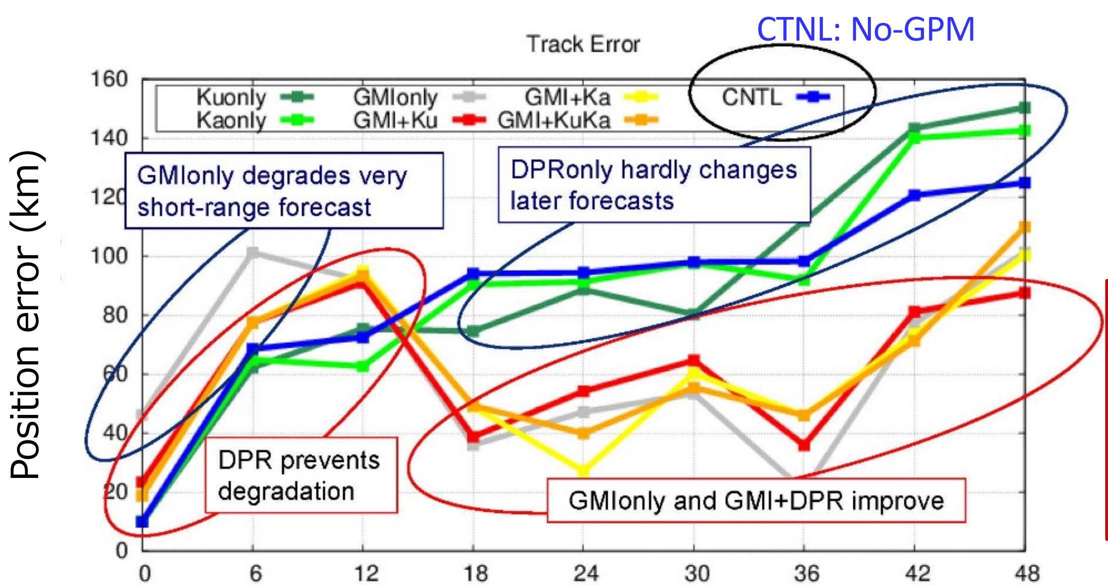
Effect of GPM-Core DA to the TC position forecast in the NWP system

K. Okamoto, K. Aonashi, T. Kubota, T. Tashima, 2016: Experimental assimilation of the GPM-Core DPR reflectivity profiles for Typhoon Halong, *Mon. Wea. Rev.*, 144 (6), 2307-2326.

Forecast verification : Position error

JMA 12/15

- DPR assimilation yields small errors in the very short-range forecast
- DPR + GMI generates smallest errors overt the entire forecast range



Exp Name	GMI	KuPR (KuNS)	KaPR (KaHS)	conven tional
1.Kuonly		O		O
2.Kaonly			O	O
3.GMIonly	O			O
4.GMI+Ku	O	O		O
5.GMI+Ka	O		O	O
6.GMI+KuKa	O	O	O	O

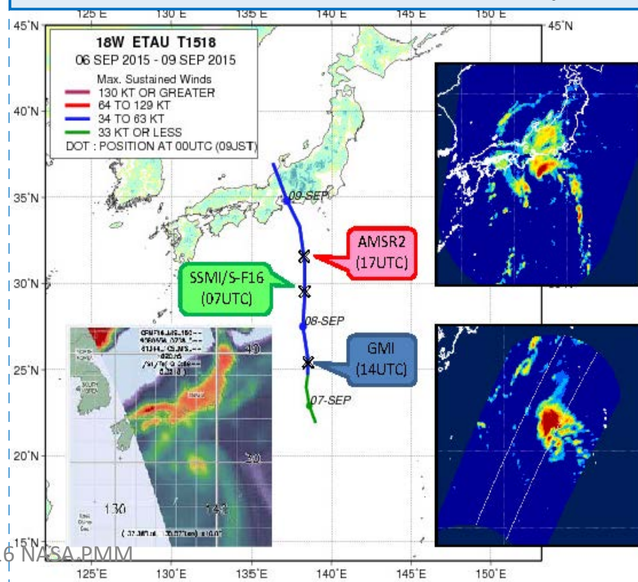
GMI DA has an essential impact on mitigation of the position error. Additional DA of DPR reflectivity profiles significantly improves the early stages of the forecast

ENSEMBLE-BASED VARIATIONAL ASSIMILATION OF GMI, AMSR2, AND SSMIS TBS FOR TYPHOON ETAU (T1518)

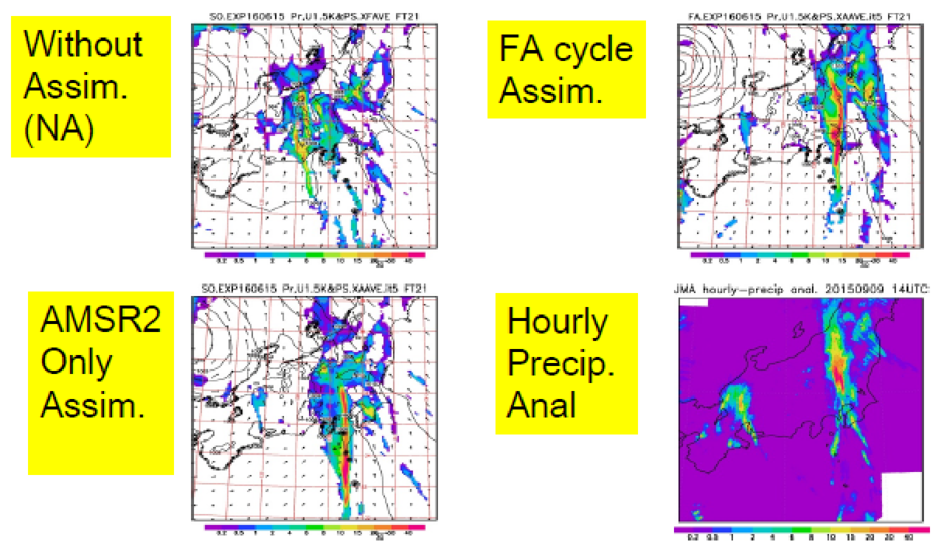
PI: K. Aonashi(MRI)

We have constructed a forecast analysis (FA) system of an EnVAR scheme for a CRM. Assimilation of GMI, AMSR2, and SSMIS TBs using this system for Typhoon Etau gave large forecast improvement of precipitation bands over Kanto plain.

The track of Typhoon Etau (T1518) and MWI TBs assimilated with the EnVAR FA system



Hourly Precip, Wind@1460m, Ps FT21 (14 UTC 9^{th})



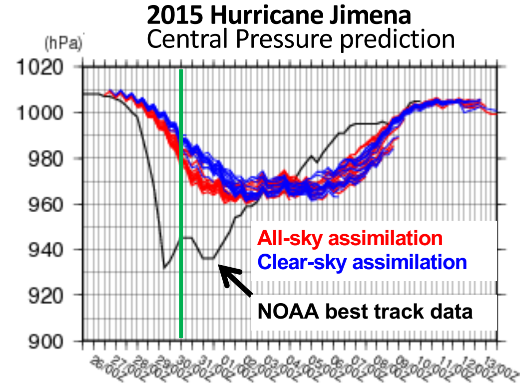
Assimilation of all-sky (cloud and rain affected) MW radiance using the JMA's global NWP system

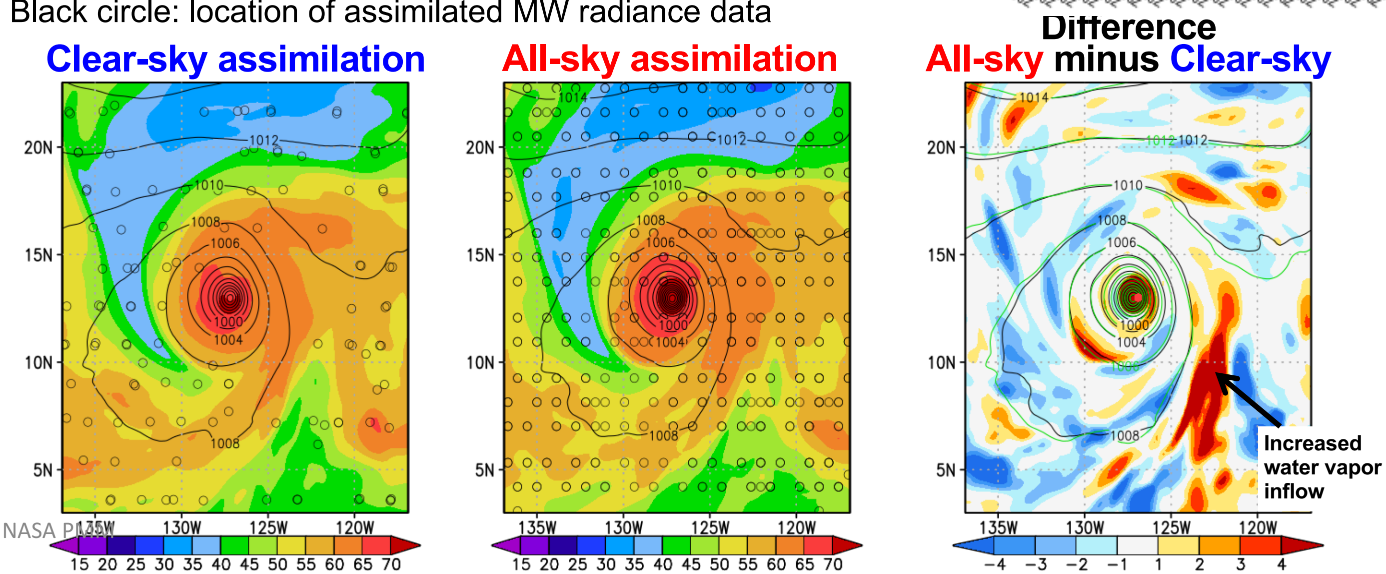
PI: Kazumori (JMA)

Preliminary experiments of all-sky assimilation of GMI, AMSR2 and SSMIS radiances

Realistic TPW concentration and deeper central pressure predictions during tropical cyclone intensification was obtained with All-sky DA

Color : Total precipitable water (mm) 6-hr forecast
Contour: Sea level pressure (hPa)
Black circle: location of assimilated MW radiance data



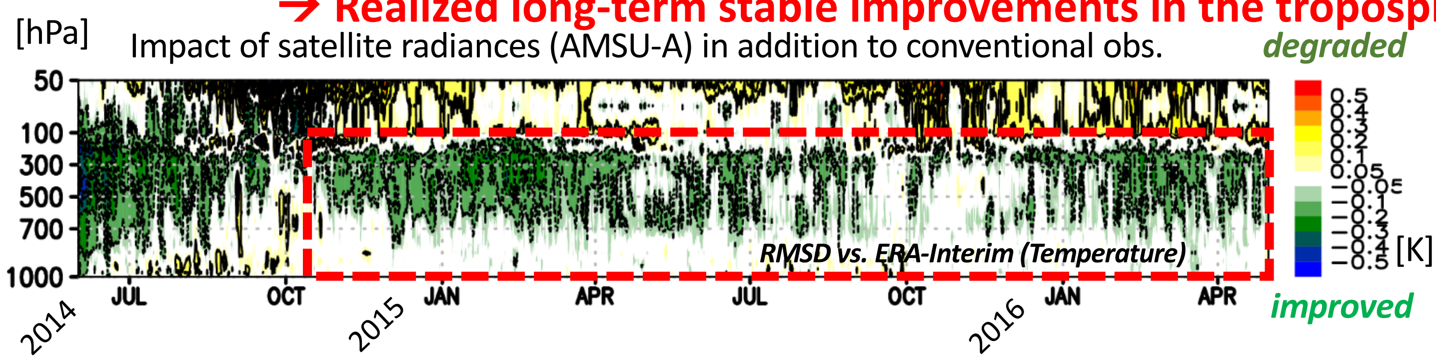


Ensemble Data Assimilation of GSMaP (PI: T. Miyoshi)

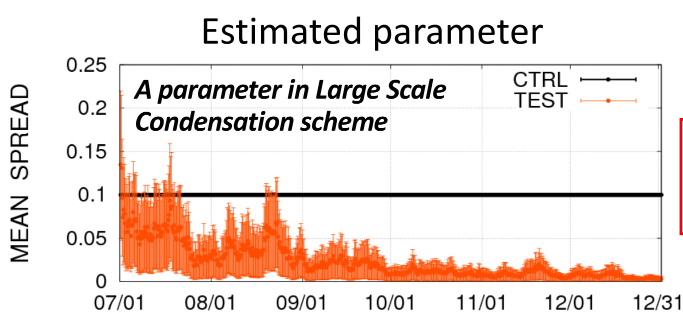
1. Real-time atmospheric DA w/ AMSU-A and NICAM (global CRM)

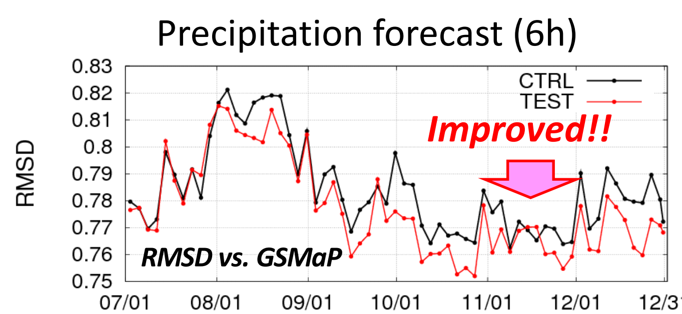
→ Realized long-term stable improvements in the troposphere

Impact of satellite radiances (AMSU-A) in addition to conventional obs.



2. LS condensation scheme Parameter was Estimated w/ GSMaP and NICAM





—: Control (wo/ parameter DA) **—: Test (w/ parameter DA)**

Summary

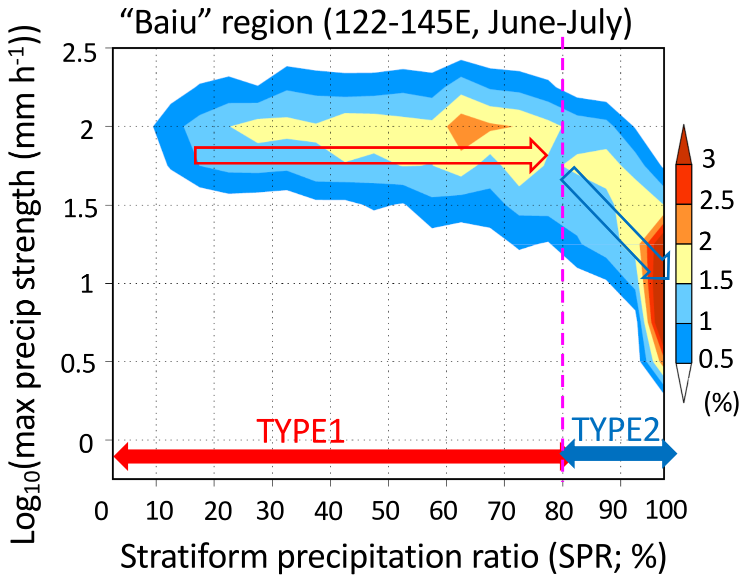
- With two years accumulation of GPM observation, upon our experiences with TRMM, we are smoothly gaining knowledge about the midlatitude precipitation.
- We are still gaining important knowledges on tropical systems as well, including tropical cyclones, with TRMM-GPM continuous observation.
- Dual Frequency Radar observation has provided us with new information about precipitation microphysics.
- Ground validation studies are ongoing with field experiments on precipitation microphysics, and product comparisons with ground based datasets.
- Various types of assimilation systems have been developed, utilizing DPR, GMI, MWs, or GSMaP, with various models e.g. JMA global NWP, NHM and NICAM. These systems have successfully improved precipitation forcasts.

Thank you

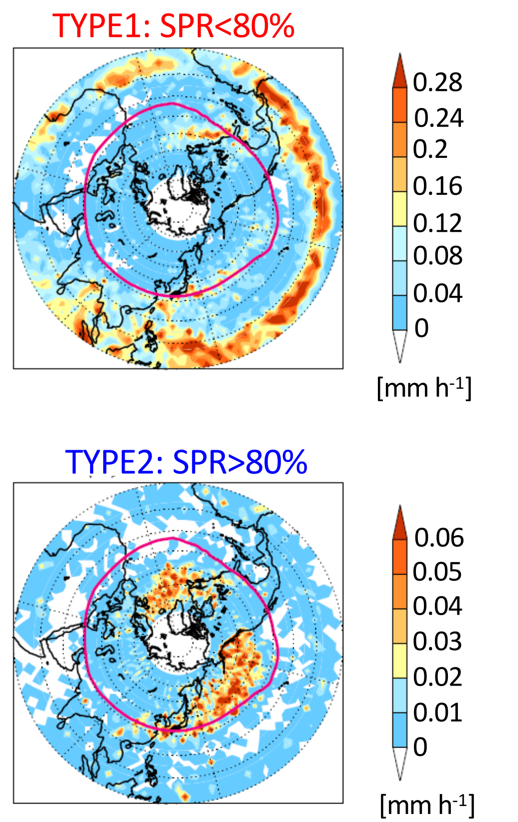
Mesoscale precipitation systems between 65N-65S

"Rainfall areas" observed with the TRMM PR & GPM Ku-band radar

Frequency TRMM



Distributions GPM (Apr'14-Mar'15)



Global mesoscale precipitation systems can be classified into two types.

I. Tropical organized precipitation systems

II. Extratropical precipitation systems

A new method of rain and snow classifications for GPM-DPR

PI: Kobayashi (MRI)

Utilizing that the dry snow does not show attenuation in Ku/Ka signals, DFRa/Ze was represented by DFRm/Ze and related to PIZ, to separate the dry snow from rain/wet snow.

Differential Frequency Ratio (DFR)

$$DFR = Z_e(Ku:dBZ) - Z_e(Ka:dBZ).$$

$$DFR = DFR_s + DFR_a.$$

DFRs: Different scattering between Ka and Ku
DFRa :Different attenuation between Ka and Ku

DFR in rain →DFR=DFRs+DFRa
DFR in dry snow, ice particle →DFR=DFRs

If we find DFRa in measured DFR, we can identify the medium as rain (or wet snow).

DFR/Ze : measure of DFRa

DFRa/Ze monotonically increase with path integrated Ze (PIZ) for rain.

Histograms of correlation coef. of DFR/Ze and PIZ